HEAT EXCHANGER DISTRIBUTOR FOR MULTICOMPONENT HEAT EXCHANGE FLUID

Technical Field

[0001] This invention relates to heat exchange using multicomponent heat exchange fluid such as multicomponent refrigerant fluid.

Background Art

[0002] In the practice of heat exchange wherein the heat exchange fluid comprises both a vapor phase and a liquid phase, it is important for the attainment of efficient heat exchange that the vapor and liquid phases of the heat exchange fluid flow through the heat exchanger with a substantially homogeneous flow. The issue of homogeneous flow and the problems resulting from substantial deviation from homogeneous flow are particularly important when the heat exchange fluid is a multicomponent heat exchange fluid, such as a multicomponent refrigerant fluid, which comprises two or more components having different boiling points. In such cases the two phase mixture is separated into a vapor phase and a liquid phase which are introduced separately and mixed in the heat exchanger.

[0003] One phenomenon which results in deviations from homogeneous flow in a heat exchanger is flow reversal. If the vapor mass fraction of the heat exchange fluid is very low, the vapor velocity may be low and liquid may drain into the vapor inlet header and become trapped thereby removing this material from circulation in the heat exchange circuit. This problem of flow reversal may be addressed by increasing the

local vapor velocity, but this solution increases the cost and reduces the efficiency of the heat exchange.

[0004] Another phenomenon which results in deviations from homogeneous flow in a heat exchanger is liquid logging. If the vapor mass fraction is very low, the liquid and vapor phases have a tendency to separate so as to provide the vapor with a path of least resistance through the heat exchanger. This results in the liquid phase becoming trapped within the heat exchanger and markedly reduces the efficiency of the heat exchange.

[0005] Accordingly it is an object of this invention to provide a heat exchanger distributor for a multicomponent heat exchange fluid which prevents flow reversal and liquid logging thereby ensuring substantially homogeneous flow of vapor and liquid phases of the heat exchange fluid even when the local fluid velocity and the vapor mass fraction of the heat exchange fluid are relatively small.

Summary of the Invention

[0006] The above and other objects, which will become apparent to those skilled in the art upon a reading of this disclosure, are attained by the present invention which is:

[0007] A heat exchanger distributor for multicomponent heat exchange fluid comprising:

(A) a main volume comprising a hardway fin section and a main fin section;

(B) means for providing multicomponent heat exchange fluid to the main volume, and means for

withdrawing multicomponent heat exchange fluid from the main volume; and

(C) a plurality of spaced dividers longitudinally oriented within the main volume, each of said dividers traversing substantially the entire hardway fin section.

[0008] As used herein the term "hardway fin" means a structure wherein the fins or corrugations are oriented perpendicular to the fluid flow thereby providing maximum resistance to the fluid flow.

Brief Description of the Drawings

[0009] Figure 1 is a cross sectional representation of one preferred embodiment of the invention.

[0010] Figure 2 is a representation of one particularly preferred embodiment of a hardway/slotted bar distributor design for use in the practice of the invention.

Detailed Description

[0011] In general, the invention enables stable homogeneous flow of heat exchange fluid, even when the vapor mass fraction and the total mass velocity of the heat exchange fluid is low, by preventing lateral movement of vapor bubbles.

[0012] The invention will be discussed in detail with reference to the Drawings. Referring now to Figure 1, heat exchanger distributor 1 comprises a main volume having a hardway fin section 2 which comprises hardway fins, and a main fin section 3 which comprises main fins such as serrated or perforated fins. Hardway fin section 2 may comprise one or two or more

subsections of different hardway fins, and main fin section 3 may comprise one or two or more subsections of different main fins. The main fin section, having fins which are oriented in line with the fluid flow, may comprise from 66 to 99 percent of the main volume. Vapor is provided to distributor 1, as shown by flow arrow 4, through vapor inlet 5, and liquid is provided to distributor 1, as shown by flow arrow 6, through liquid inlet 7 to distributor bar 10. Homogeneous mixed phase heat exchange fluid is withdrawn from distributor 1, as shown by flow arrow 8, through outlet 9. Preferably, as shown in Figure 1, distributor 1 is vertically oriented such that the heat exchange fluid flows upwardly through the main volume.

[0013] A plurality of spaced dividers 11 are longitudinally oriented within the main volume. Each of these dividers traverses substantially the entire length of the hardway fin section. In the embodiment of the invention illustrated in Figure 1 each of the spaced dividers additionally traverses at least a portion of the main fin section. The dividers may extend the entire length of the main volume. The dividers are placed with a gap preferably not larger than 0.0625 inch from the distributor bar and are placed at least 3 inches apart. The width of the dividers is preferably about 0.125 inch. Preferably the entire assembly is brazed in a furnace.

[0014] The operation of the invention with respect to the embodiment illustrated in the Figures will now be described.

[0015] Prior to entering distributor 1 the two phase multicomponent fluid is separated into a vapor phase

and a liquid phase. The liquid phase is fed to the inlet header tank 7 wherein it is divided evenly between the layers of the heat exchanger. On entering a single layer the liquid phase flows into the liquid side of distributor bar 10. The liquid side of the distributor bar 10 is sealed against the vapor side from below, so it is impossible for liquid to drain into the vapor header tank via this route. Liquid is distributed within each layer by means of openings in the top of the liquid side of the distributor bar. Dividers 11 define a number of heat transfer subsections in the main volume in which the liquid flow is evenly distributed and mixed with the vapor phase to form a homogeneous two phase mixture.

[0016] The vapor phase is fed to the vapor inlet header tank 5 and directed to distributor bar 10 via a section of plain fins. The local vapor velocity in the vapor side of distributor bar 10 is substantially higher than in the main volume so as to prevent liquid from draining back into the vapor inlet header. One method of achieving this is to use narrow slots on the vapor side of the distributor bar. Another method is to use a section of hardway fins with a fin height of about 0.2 inch, which is roughly half the height of a layer (0.375 inch). One arrangement for effecting this latter method is illustrated in Figure 2 wherein the vapor side 20 and liquid side 21 employ hardway fins 22 and a slotted bar 23 for the flow of vapor 24 and liquid 25 respectively. Seal 26 is used to prevent liquid drainage.

[0017] The vapor phase is fed evenly to each of the heat transfer subsections wherein it is mixed with the

liquid phase. The two phase mixture leaving distributor bar 10 is heated and vaporized in the main volume. In the initial part of the main volume, the average velocity is low which limits the rate of heat transfer. For this reason hardway fins are employed to greatly increase the heat transfer rate. As more vapor is generated further up the main volume, the pressure loss increases to an unacceptable level. Hence conventional fins, such as serrated or perforated fins are employed in place of hardway fins. The two phase mixture is partially or completely vaporized in the main volume and leaves the heat exchanger via a section of plain fins which direct the flow to the outlet header tank 9.

[0018] In the invention the dividers serve to prevent lateral movement and agglomerization of gas bubbles. By the prevention of this lateral movement and agglomerization, the vapor and liquid phases of the heat exchange fluid are prevented from separating. In this way, a homogeneous vapor liquid upflow is maintained, even when the total mass velocity is low.

[0019] Although the invention has been described in detail with reference to a certain preferred embodiment, those skilled in the art will recognize that there are other embodiments of the invention within the spirit and the scope of the claims.